CHEM102 Exam I (Jul 20 2009).
$33\frac{1}{3}$ points / problem with maximum of 100 points.

1. For $2NaCl(aq) + Ag_2SO_4(aq) \rightarrow 2AgCl(s) + Na_2SO_4(aq)$ the following data was obtained at 298 K:

[NaCl] (mol L^{-1})	[Ag_2SO_4] (mol L^{-1})	Initial rate of reaction (mol $L^{-1}s^{-1}$)
0.104	0.084	28.8
0.104	0.021	1.80
0.208	0.021	7.20

a) What is the rate law?

b) What is the value of the rate constant $k_{298\ \mathrm{K}}$ (where the subscript refers to temperature)?

c) What rate law would you expect if this was an elementary reaction?

d) If the pre-exponential factor A is independent of temperature and $k_{400\ \mathrm{K}} = 10 \times k_{298\ \mathrm{K}}$, what would be the activation energy E_A (the gas constant $R = 8.31451$ J $K^{-1}mol^{-1}$)?

2. Consider the following elementary reaction: $NO_2(g) + NO_2(g) \rightarrow N_2O_4(g)$. The rate constant $k = 0.044$ $M^{-1}s^{-1}$ is known.

a) What is the reaction order with respect to NO_2?

b) If the initial concentration of NO_2 is 0.200 M, what is the concentration of NO_2 after 10 minutes?

c) What would then be the concentration of N_2O_4 after 10 minutes?

d) How would you expect entropy to change in this reaction (and why)?

3. The formation of iron oxide follows the reaction at 298 K temperature:

$$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$$

where $\Delta H^\circ_{\mathrm{rxn}} = -824.2$ kJ/mol and $\Delta S^\circ_{\mathrm{rxn}} = -549.7$ J/(K mol).

a) Calculate $\Delta G^\circ_{\mathrm{rxn}}$. Can you predict spontaneity of the reaction using this thermodynamic variable?

b) Calculate $\Delta S^{\circ}_{\text{universe}}$. Can you predict spontaneity of the reaction using this thermodynamic variable?

c) Is there heat transfer involved in this reaction between the system and the surroundings? Calculate q_{sys} and q_{surr}.

d) Can you predict the sign of $\Delta S^{\circ}_{\text{rxn}}$ from the chemical equation (and why)?